Reporting Federal Activities . . .

Higher Education

Features for DECEMBER 1960

Scientific Progress, Universities, and Federal Government

By THE PRESIDENT'S SCIENCE ADVISORY COMMITTEE

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
Office of Education

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STATEMENT
BY THE PRESIDENT

This report is part of a continuing study by my Science Advisory Committee of ways in which the Federal Government can best assure the strength and progress of American science, one of our essential resources for national security and welfare. I hope it will be favorably received and widely studied by everyone in our national community concerned with the advancement of scientific knowledge through basic research and with the education of young scientists.

I call particular attention to the conclusion of the Science Advisory Committee that the process of basic scientific research and the process of graduate education in universities must be viewed as an integrated task if the nation is to produce the research results and the new scientists that will maintain the leadership of American science. In this great endeavor, the partnership between the Federal Government and the nation's universities will assume growing importance in the future.

/s/ Dwight D. Eisenhower

The White House
November 17, 1960

Scientific Progress, the Universities, and the Federal Government

By The President's Science Advisory Committee*

PART ONE—THE GENERAL PROBLEM

I. Introductory—the focus of the report

This paper is a brief statement on a large set of problems: the problems which center on the advancement of science by basic research, and the making of scientists by graduate education. This is only one part of the complex world of modern American science, but it is a critically important one. We have tried to state clearly the fundamental character of the environment which is required for scientific progress *and* for the making of good young scientists. We then consider the way in which these requirements should affect the policies of both the Federal Government and the universities, which are today the two forces in our society whose actions most affect the health and strength of basic research and the training of scientists.

We find much, both in the government and in the academic community, which needs improvement, but we have made no attempt to prescribe detailed policies for either party. The last twenty years have seen a remarkable growth of support of many kinds for basic research and graduate education, and the role of the Federal Government has on balance been highly constructive. On the whole our universities are much stronger today in science than they were a generation ago. We have great confidence that energetic leadership and constant effort can find good answers to the practical problems of the future. A short statement like this may hope to contribute,

*This is an abridged version, prepared especially for *Higher Education*, of the Statement issued Nov. 15, 1960, by the President's Science Advisory Committee. The members of the Committee, its Panel on Basic Research and Graduate Education, and the Consultants to the Panel, are listed on page 17. The full text of the Statement is available from the Superintendent of Documents, Government Printing Office, priced at 15 cents.

not specific solutions, but rather some general ideas about the nature of the task and the principles that should guide us in working on it.

II. The background: the urgent need for scientific progress

Both the security and the general welfare of the American people urgently require continued, rapid, and sustained growth in the strength of American science. Other reports of qualified bodies, and earlier reports of this Committee,[1] have argued in detail the reasons which make this growth vital to us all. We believe that most Americans are in favor of more and better science. In a general way Americans recognize that scientific understanding is at once highly valuable in its own right and quite indispensable for the sustained progress of a modern industrialized society. We are proud of our great accomplishments, and we become concerned whenever it appears that our scientific effort in any field may be second-best. Most of all we have learned to recognize that the defense and advancement of freedom require excellence in science and in technology.

But our acceptance of these quite modern ideas does not mean that we understand fully their consequences for our policy and practice. American science in the next generation must, quite literally, double and redouble in size and strength. This means more scientists, better trained, with finer facilities. Many forces contribute to this urgent need for growth.

Our population is rapidly increasing, so that there are more and more young people to be taught, and we have nothing like the number of qualified teachers we need even now. Science itself is expanding so fast that our efforts would have to be much increased, if we were only to keep up with its general international momentum. The training of scientists takes longer than it used to, and the facilities needed in a modern laboratory are usually much more complex and expensive than those that were needed only a few years ago. Science and technology today have steadily growing mutual impact, so that the practical man has need of the closest and most immediate access to new results in basic science. Thus both science and scientists must be more and more widely diffused throughout our society. We need more men doing more things, with more support, in more places. And each of these requirements is better measured by multiplication than by addition. It is the simple truth that if this country is to safeguard its freedom and harvest the great opportunities of the next generation of science, the level of its scientific investment must be multiplied and multiplied again.

Much of this basic argument for the strengthening of American science applies equally to other fields of learning. While this report centers on the needs of science, we repudiate emphatically any notion that scientific research and scientific education are the only kinds of learning that matter to America. The responsibility of this Committee is limited to scientific matters, but obviously a high civilization must not limit its efforts to science alone. Even in the interests of science itself it is essential to give full value and support to the other great branches of man's artistic, literary, and scholarly activity. The advancement of science must not be accomplished by the impoverishment of anything else, and the life of the mind in our society has needs which are not limited by the particular concerns which belong to this Committee and this report.

We do not, in this report, attempt to consider what direct responsibility and interest the government has for strengthening basic research and graduate education outside the sciences. This is a subject which deserves careful attention, but it is beyond our mission. What we can say, however, is what earlier reports of this Committee have regularly emphasized, that neither the government nor the universities should conduct the support of scientific work in such a way as to weaken the capacity of American education to meet its responsibilities in other areas. The costs of scientific progress must not be paid by diverting resources from other great fields of study which have their own urgent need for growth.

III. Basic research and graduate education—they go best together

Science is a large field, and in this report we want to concentrate attention on two parts of it: the part in which research is pursued with the purpose of

[1] See, for example, *Strengthening American Science*, a report of the President's Science Advisory Committee, Washington, 1958; *Education for the Age of Science*, Statement by the President's Science Advisory Committee, Washington, May 24, 1959; and *Basic Research—A National Resource*, A Report by the National Science Foundation (NSF 57-35). Washington, 1957.

advancing scientific understanding, and the part in which young college graduates are helped to become scientists. Our shorthand terms for these two activities are "basic research" and "graduate education."

It is a fundamental contention of this report that the process of graduate education and the process of basic research *belong together* at every possible level. We believe that the two kinds of activity reinforce each other in a great variety of ways, and that each is weakened when carried on without the other. We think also that this proposition has substantial implications for the policy of both the Federal Government and the universities. Because the proposition is so central to our argument, we must try to demonstrate it thoroughly.

In one sense, it is almost self-evident. If graduate education aims at making scientists, and if inquiry into what is unknown is the moving principle of all science, it is not surprising that experience of this kind of inquiry should be essential in graduate education. Clearly such experience is best obtained in association with others who have had it or are having it themselves. The apprentice scientist learns best when he learns in an atmosphere of active research work. It is true that only a minority of those who receive a Ph.D. in science continue their subsequent careers in basic research. The majority go on to applied research in industry or to teaching in college where research opportunities are limited. (Even in the universities many scientists are not active in research.) Nevertheless, such experience as all graduate students should have with basic research is highly important. In all forms of scientific work a man's effectiveness is multiplied when he has that depth of understanding of his subject that comes only with the experience of working at a research problem.

But if all this is so, it does not seem to be fully recognized in the standard practices of most universities and Federal agencies. For as we are describing it, the process of graduate education depends on "research" just as much as upon "teaching"—indeed the two are essentially inseparable—and there is a radical error in trying to think of them as different or opposite forms of activity. From the point of view of the graduate student, the teaching and the research of his professor are, at the crucial point which defines the whole, united. What he learns is not opposite from research; it *is* research. Of course many necessary parts of a scientist's education have little to do with research, and obviously also for many professors there must be a gap between teaching a standard graduate course and working at one's own problems. Moreover, many good teachers—men who keep up with the new work in their subject and communicate its meaning clearly to their students—are not themselves engaged in research. Yet we insist on the central point; the would-be scientist must learn what it is like to do science, and this, which is research, is the most important thing he can be "taught."

So far we have been arguing that graduate education requires the experience of basic research. What happens when we turn the matter around, and ask whether basic research must be carried on only in conjunction with graduate education? Here the answer cannot be so categorical. Though our general conviction is that a fundamentally reciprocal relation does exist, it is clear that research of outstanding quality is often carried on in isolation from teaching and indeed quite outside the universities. While the great teacher of graduate students is almost invariably a research man too, there are many notable scientists who have as little as possible to do with teaching. First-rate industrial and governmental laboratories with commitments to specific programs are necessarily separated in some measure from teaching of a conventional sort. Thus basic research can be and is carried on without much connection to graduate education.

Yet in the long run it is dangerous to separate research in any field entirely from education. If a research field is to be attractive to good young men, it ordinarily needs roots in the universities. The pool of graduate students in our universities is the pool from which the scientists of the future must come. These young people do not easily study what is not taught; they do not often learn the meaning of research which does not exist in their environment. A scientific field which has no research life in the universities is at a grave disadvantage in recruiting new members. As learning and teaching require research, so research, in the end, cannot be sustained without teaching. Hence it is always important for research installations to maintain effective connections with students. In a later section we note some of the consequences of this rule for both the government and the universities.

Meanwhile it is worth noting that the practical need for connection between a research installation and the source of scientists is not the only reason for doubting the value of any sharp separation between research and teaching. There is also the fact that in the wider sense all first-rate research laboratories are permeated by an atmosphere of learning. Successful research can be defined, indeed, as learning what has not been taught before, and a good scientist is constantly learning from others as a part of his campaign to find out something on his own. It is not an accident, therefore, that in any outstanding industrial or governmental laboratory the atmosphere is reminiscent of the university. In such laboratories, moreover, the scientist's concern with "research for its own sake" is often very strong; much excellent basic work is done in such laboratories, in support of general programs of applied research.[2] We believe that research, learning, and teaching are deeply connected processes which should be kept together wherever possible. Not all basic research should be—or could be—performed in our universities, but where it is done separately, special efforts should be made to take advantage of its educational value.

IV. The role of the Federal Government

Basic research and graduate education, together, are the knotted core of American science, and they will grow stronger together or not at all. Let us now consider the consequences of this principle, first for the government and then for the universities. The Federal Government, by its varied missions and the size of its financial commitments, is the most powerful single force in this whole field, while the universities are the natural holders and custodians of the knotted core. Both have done much to strengthen and something to weaken the common enterprise in recent decades. Both must do better in the years ahead.

The Federal Government, through many agencies, is now by far the most important source of funds for research in the universities. In 1957–58 the Federal share in all such research was about 70 percent. This astonishing expansion in Federal activity is the product of several forces, all of them initially related to specific needs of specific branches of the government. The two most important purposes of the government in supporting research have been defense and health; more than three-fourths of all Federal funds for such research in 1959 came from agencies with one or the other of these two missions.

The government's first interest in its relations with universities was to obtain the practical advantages of research. Historically, the earliest large-scale relations were those in the field of agriculture, which connected the government to the land-grant institutions. Then during World War II, American science conclusively demonstrated its practical value, and in the years after the war, first the defense agencies and then those related to health developed large-scale research relations with the universities. At first these relations were based on contracts allowing compensation for services rendered. Government contracts have supported a great deal of research of high quality; they have, for example, paid for almost all of our remarkable post-war effort in nuclear physics. Nor has this support been limited narrowly to the fields with high practical significance or political appeal.

Yet in its essence the concept of "purchase of services," which is implied in any government contract, was and is a doubtful one, when applied to basic research. Basic research, almost by definition, has no clearly predictable practical result, and so the Congress and the Federal agencies involved have had to interpret very broadly the notion of "value received" in return for sums spent on research contracts. But conversely, the support of university research has been hampered by contract rules which strictly limit the ways in which universities can be compensated for their costs. The whole framework is somewhat arbitrary and unrealistic. The wonder is that it works as well as it does.

From the point of view of this report, a particularly grave difficulty in the support of research by government contracts is that by its very nature support given through such a mechanism tends to separate research from education. In the research contract the one recognized "product" is "research;" yet if the government has an interest in basic research in any given field, it inevitably has a related interest in graduate education in the same field. Thus the government is almost forced to work against its own interest as well as that of the university when it uses

[2] That basic research is an important element in the quality of any mission-oriented laboratory in the government was argued earlier in *Strengthening American Science*, pp. 18, 32. Nothing in this report should be taken as a modification of that position.

an instrument whose formal concern is with research results alone. It is greatly to the credit of many able public servants that this inherent difficulty has often been overcome by imaginative and farsighted administration. Many graduate students have been helped by contract funds in a fashion that is both constructive and proper. But the research contract, with its concept of services purchased, remains an imperfect instrument. Even for the advancement of basic research as such it is awkward, because first-class research is really not a service to be contracted for. And for larger purposes it is wholly inadequate.

All government agencies are now empowered to use grants instead of contracts in supporting basic research; the National Science Foundation and the National Institutes of Health, particularly, have used this form extensively for some years. The use of grants sometimes has the regrettable consequence of failing to provide for the full cost of the research that is supported, and sometimes the complexities of application and processing for even a small project grant compare unfavorably with the best practice of contracting agencies. But on balance and in the long run, the grant is a better instrument than the contract—it is more consistent with the nature of basic research.

Grants and contracts are both used to support specific research projects. This is good, in and of itself—especially when such support is provided, as it often is, with a minimum of red tape and for broad objectives, with relatively long time-schedules (3-year terms were recommended in an earlier report). Support of good men or groups in specific projects can be particularly effective in ensuring that excellent scientists and excellent problems are identified wherever they may be. While the process of evaluation and award is time-consuming both for government officials and for outside scientists who serve on advisory panels, it is well done, on the whole. But project support, in and of itself, does not fully meet the needs of the Federal Government.

We can understand this matter better if we consider for a moment the Federal Government's larger purposes in relation to basic research and graduate education. In addition to the research interests of particular agencies, the government has two other more general responsibilities. One is its concern for the development of fields of basic and applied science which may be of general importance for the national security and the general welfare; the other is its concern for the strength of American science and higher education as a whole.

There are many fields of science in which the United States could well become stronger and more active, both from the point of view of the national defense and from that of the public welfare. It is unfortunately not true that scientists always and automatically sort themselves out into the most relevant and productive fields of work. Science like any other human activity is subject to the distortion of human frailty, and scientific fashion is not always sound. Moreover, even when individual scientists spot promising untilled fields (and it is scientists who do spot them) it is often hard to find funds and facilities for the new undertaking from within hard-pressed universities.

We think it plain that the Federal Government should act in such areas of scientific promise. No other agency in our society is responsible for the national security, and a large field, full of new problems, such as space science or materials research, is potentially vital to our safety. No other agency in our society is responsible for the general welfare, and all major fields without exception can be expected to contribute to the general welfare. No other agency, finally, has the financial strength to provide the necessary support—and incentive—for work in expensive new undertakings. It can be said without qualification that our society will be endangered and impoverished if these things are not done, and that only the Federal Government can take the leadership to get them done. We do not mean, again, that only Federal action will be needed; we do mean that it must play a large initiating and sustaining role.

When we construe the matter in this way, it becomes clear that no narrow or single-instrument method of action will serve the government's purposes. For example, if oceanography is urgently important (as it is), if good oceanographers are scarce (as they are), and if oceanographic facilities—especially modern sea-going vessels—are almost nonexistent (also the case), the Federal Government cannot discharge its responsibilities by signing a research contract with any one institution. It has to look at the whole subject and all its needs. It may be more important to buy some university a ship—as the National Science Foundation has recently done—than to execute a research contract for

work under one of its professors. It may also be be important to offer fellowships or to assist in the initial expense of a new set of courses. The government will not be able to serve its own interest if it cannot put its money freely wherever it sees an urgent need.

In speaking of new fields of need and opportunity, we are seeking to emphasize the things that now need doing. We could also call attention to the many things that have already been done, above and beyond the standard research contract. The Federal Government has, of course, already built major research facilities when no one else could—most notably in the field of nuclear physics. It has also begun to make grants for research facilities as well as for research—most notably in the field of health. The National Science Foundation, with the broadest charter of any agency in the field, has granted fellowships both directly to students and indirectly through universities, and recently it has planned to make unrestricted research grants to institutions receiving funds on a project basis from its hands. Nor should we neglect the imaginative use of training grants in medicine and health, the fellowship program of the Atomic Energy Commission, or the special help made possible by the National Defense Education Act. Still all of these are limited *ad hoc* programs which only partially meet the government's own interest in graduate education and basic research; we have hoped, by discussing a new topic like oceanography, to show how general and unlimited that interest can be.

The government has one still greater interest in these matters. It is, quite simply, that university science should be as strong as possible. This blunt statement does not arise from sentimental affection, or from professional affiliation, though most of us must confess to both. It is rather that the function of the universities is one of absolutely critical importance to the national welfare. As our scientific efforts have expanded in many industries and government installations, the universities have naturally lost their near monopoly on scientific work. But it is essential that this process should not go too far. For the universities are the source of tomorrow's scientists, as they are the natural centers for jointly thriving basic research and graduate education.

Obviously this proposition has meaning for many others besides the Federal Government. The universities themselves are not without resources, and they have a particular and urgent obligation to spread the word of their high mission wherever they have friends who can help. State governments, graduates, generous private citizens, and foundations all have a part to play in strengthening the American university. Moreover, as we shall presently see, the American university has a special opportunity and obligation to see to it that its responsibility for judgment and leadership in basic research and graduate education is well discharged.

But when all these things have been said, the first and greatest of responsibilities comes back to the Federal Government. No matter how many diverse elements of our society may join in their support (and the more the better), basic research and graduate education are in the end, by their very nature, a problem for the nation as a whole, and so for the national government. There is not one physics for California and another for Texas. A first-rate program in Massachusetts or Connecticut must not be limited to New Englanders. Science flourishes by honorable rivalry, but not by any effort to consider only narrow or local interests. Both basic research and graduate education must be supported in terms of the welfare of society as a whole. It is in this large sense that the role of the Federal Government is inevitably central.

The truth is as simple as it is important: *Whether the quantity and quality of basic research and graduate education in the United States will be adequate or inadequate depends primarily upon the government of the United States. From this responsibility the Federal Government has no escape. Either it will find the policies—and the resources—which permit our universities to flourish and their duties to be adequately discharged—or no one will.*

It is much easier to state this general interest of the Federal Government than it is to delineate its consequences. Indeed, in the largest sense the consequences are too many for numbering, because in essence this general proposition should color every action of every Federal agency in all its dealing with our universities. With all their irritating faults, universities are essential agencies of our national hopes, and they must be treated accordingly.

V. The job of the universities

American universities are far from perfect, and their best spokesmen are the first to admit it. In a sense they do not have the excuse of government,

which has entered the field only recently; their very reason for being is that they should support the high purposes we are concerned with here. Basic research and graduate education—as we have said and all will easily agree—are of the very essence of the fundamental purposes of the American university. Yet many do much too little, and none does all it should, in these great areas.

In the first place, it is often as hard for the university as for the government to keep it clearly in mind that *basic research and scientific education* go together. The first and simplest temptation, we fear, is the neglect of research. Most American universities have their origin in a public need for education—for instruction—for teaching—and in most of them there is still maintained the same artificial and fundamentally wrong division between research and teaching that bedevils the government's relations with universities. But while the government finds it easier to pay for research than for teaching, the university, too often, budgets for teaching as a matter of course, and for research only when special circumstances permit. The result is that in all but a few American universities the standard teaching assignment of the professors (significantly called his "teaching load") is such as to make it difficult for him to carry on any serious program of investigation of his own.

On the other hand, the university itself sometimes allows favored individuals to play no teaching role whatever, as a means perhaps of attracting and keeping men of particularly outstanding reputation. The danger in such a practice is obvious, since it appears to suggest that the very best men deserve exemption from teaching. While in any individual case such arrangement may be justified, it is of the first importance that universities—and scientists themselves—should sustain the value of teaching as well as research.

More broadly, our universities have been slow in finding effective ways of encouraging scientific research and training at all the new levels and in all the new ways which the age of science makes possible. Graduate education is not as good as it should be. Outmoded rules of study too often impede the student's access to the experience of modern science. Research programs are too often kept in isolation from the mainstream of student life. Special research installations are too often not imaginatively used as a source of learning and teaching. New fields of study are ignored because they inconveniently cross departmental barriers. Strong understanding of the meaning of the age of science is too rarely found among university administrators. The universities themselves have much to do.

Perhaps the most important single task of the universities is to see to it that their own standards of freedom and excellence are maintained in a period of growing connection with government. While we do not share the notion that government money is necessarily subversive of university freedoms, it is obvious that large-scale Federal spending, like any other form of patronage, has its hazards. In the record of the last fifteen years, there is much more ground for hope than for fear, but occasionally government action has distorted the direction of research or unwisely discriminated against particular scientists on irrelevant grounds. It is to the credit of the government that such cases have been the exception, not the rule, and we commend the good sense which has led the Administration to oppose discriminatory and useless affidavits of disbelief as a condition for fellowship aid.

But the first and greatest responsibility for keeping our universities free and self-reliant rests with the universities themselves—with their faculties, their administrators, and their trustees. What they do not defend, others will not find it easy even to understand, while, when they are staunch in their principles and vigilant in their practices, the record suggests that neither the Federal Government nor any other source of support is an overwhelming threat to them. Courage and vigilance are essential, but there is no ground for a timid mistrust of government in and of itself. The right concept is that of partnership, with each partner respecting the rights and responsibilities of the other. For this there is need for a constant effort of communication and understanding, and we repeat that the first responsibility here rests with university people.

The partnership is a fact. It has done much more good than harm. It seems certain to grow in importance unless the American people decide to accept a second-rate standing in terms of power, of comfort, and of knowledge. The broad problem which faces the government and the universities is to make the partnership fully fruitful. The remainder of this report is devoted to a number of specific issues on which it seems possible to make useful comments at this time. But particular issues are subject to change from year to year, and we do

not wish to put our main emphasis on any one question in itself. In a sense these comments are illustrative rather than exhaustive or definitive—the main thing, once again, is to think of basic research and graduate education together.

PART TWO—SOME SPECIFIC CONCLUSIONS

I. Excellence deserves strong support

In the advancement of science the best is vastly more important than the next best. Mediocre research is generally worse than useless, and the same may probably be said of teaching. It is, therefore, of first importance that national support for both activities should aim at sustaining and reinforcing outstanding work wherever it may be found. Both the Federal Government and university administrators should be firm in their support of what is first rate even when such support requires hard choices.

II. Additional centers of excellence are urgently needed

Equally with the importance of sustaining what is already outstanding, we urge the importance for the country of an increase in the number of universities in which first-rate research and graduate teaching go forward together. The growth of science requires more places with superior faculties and outstanding groups of students. Existing strong institutions cannot fully meet the nation's future needs. It is true that experience is casting doubt on some conservative notions about the optimum size of the university, and the universities which are already great are larger than they expected to be ten years ago. But there is a limit to such growth, and we must hope that where there were only a handful of generally first-rate academic centers of science a generation ago and may be as many as fifteen or twenty today, there will be thirty or forty in another fifteen years. Timely and determined support to the rising centers will be repaid many times over in service to society.

III. Graduate education needs expansion

As our whole report emphasizes, we believe that graduate education leading to the Ph. D. should include a genuine experience of research. It is experience of research that makes a man a scientist. We think this kind of graduate education is needed not only for those who go on in university science, but also for college teachers and increasingly for the more important scientific and technological positions in industry and government.

Thus we need more men and women with the advanced training the Ph. D. symbolizes. No fixed projection of exact numerical needs seems convincing to us, and there is a sense in which we can always make do with what we have. But in terms of return on an investment, again, we believe that a steady and rapid growth in our national output of scientists, in all fields, will be well worthwhile.

IV. It is important to attract a larger number of talented students to science as a career

If we are to have more good scientists, the first necessity is that more of our talented young people should want scientific careers. It is here that our colleges, whether or not they are parts of universities, can contribute largely. We believe that both colleges and the Federal Government should give urgent attention to the quality of collegiate instruction in the sciences. The first and greatest need is to extend to the college the connected concern with teaching and investigation which we have emphasized throughout. This does not mean that every college must be a university, or that every college teacher must be a dedicated research man, but it does mean that the opportunity and practice of scientific inquiry should be a part of the life of the college laboratory. This is not an easy goal; even in universities the teaching of undergraduates is often sharply separated from the research life of the institution. But once the problem is squarely recognized, much can be done. Decent salaries, time for research, facilities for good scientific activity, and modernization of curriculum can all be helpful. Indeed the short way of saying it is that most of the comments and conclusions we offer with respect to graduate education can be applied with only moderate adaptation to scientific work in the undergraduate liberal arts college. We repeat that nothing can do more for the supply of talent to the sciences than a general renewal of life and energy in collegiate science.[3]

[3] Of course college education in the liberal arts and sciences has many other values beyond what we here emphasize; it is only in the present context that we limit ourselves to the particular and urgent topic of attracting talent to the sciences.

V. Graduate education in science needs constant modernization

Our basic acceptance of the Ph. D. degree does not imply any similar acceptance of all that is now done in its name. We think it urgent that graduate education be constantly revised and improved. As science itself rapidly advances, we need new ways of teaching and learning both traditional and emerging subjects. Many university departments are more rigid in formal requirements—and more lax in insistence on real achievement—than they ought to be. Many traditional programs for the Ph. D. are now a poor preparation for serious contemporary research, and too few university scientists have given proper thought to the ways in which the learning of science can be improved at all levels by imaginative changes of method. We are at the edge of great advances in our scientific knowledge of what the process of learning is, and it would be an irony if science itself were to lag in the application of its own achievements. Fortunately there appears at present to be a marked revival of interest among scientists in the improvement of both teaching and learning.

VI. The financing of graduate education needs continued and flexible reinforcement

Graduate studies leading to the Ph. D. are very expensive, both for the university and for the student, and neither party is adequately supported. Great improvements have occurred in recent years, but a great deal still needs to be done. Lack of financial means is probably the greatest single difficulty faced by the American graduate student. It is their lack of means, for example, that is mainly responsible for the undue length of time so often consumed in achieving the Ph. D. degree. Too many students simply cannot find the money for sustained full-time study and drop out or take part-time jobs that delay their progress and flatten their spirits.[4]

The best and most direct form of support for graduate education is the graduate fellowship. The government has a number of such programs, and on balance they have been highly constructive. We believe that these programs—and in particular the well-designed and effective fellowship programs of the National Science Foundation—should be expanded just as fast as truly promising candidates can be found. A properly designed fellowship program is highly rewarding in its eventual return on every dollar invested.

The natural selection and selective reinforcement which can be supported by fellowships seem to us to constitute a strong argument for including in every fellowship a substantial additional grant for the support of the institution itself as well as the graduate student. The cost of graduate education to the university always far exceeds the tuition charged to the individual, and therefore university authorities have regularly pointed out that without a supplementary grant they must expect to "lose money" on each fellowship winner. This in itself may not be a wholly persuasive argument, since the university's other resources are at least partly aimed at this same educational purpose. But we believe that fellowships are a good instrument for effective distribution of general support to universities where it will do the most good. We therefore recommend that, as a general rule, graduate fellowships supported by the Federal Government should include a substantial supplementary grant for the general support of the related work of the university. Since the average graduate student in science costs his university not less than $3,500 a year,[5] grants which provide this amount to the institution would not be excessive. (Where tuition is already covered by the basic fellowship grant—the usual case—the supplement should of course be reduced accordingly.)

VII. The need for improved facilities is urgent

The dramatic expansion of science in this country has outrun our ability to provide up-to-date space and equipment for either research or teaching—still less for the two together. While in the end men are more important than facilities, the immediate bottleneck today, in many fields and in many universities, is in buildings and equipment. In part this backwardness is the result of a widespread and quite erroneous notion that it is less fruitful to pay for a building or for its maintenance than for research or

[4] For extended discussion on this point, the reader is referred to Bernard Berelson's important study, *Graduate Education in the United States* (New York: McGraw-Hill, 1960).

[5] This figure is based on recent estimates collected by the Office of Education; the estimates relate to all fields of learning, and it seems most probable that scientific education is in general the most expensive kind. Estimates of cost in this field are very uncertain, but we feel confident that our figure is conservative.

teaching in themselves. Very little good laboratory work can be done without a roof, and in experimental science the best equipment is usually the true economy.

These propositions carry a moral for both universities and the government. Neither side should expect to develop first-rate programs without appropriate space and equipment, and on both sides an increased emphasis on investment in facilities is desirable. We warmly approve the recent general endorsement of facilities grants by the executive branch, and we particularly commend the initiation of programs in this area by the National Institutes of Health and the National Science Foundation. While we do not believe there is any permanent magic in the matter, we see considerable practical advantage, for the present, in the practice of sharing the costs of such facilities between the Federal Government and other sources. Grants contingent upon some degree of "matching" tend to encourage other sources of support, and to ensure that the receiving institutions have a serious commitment in the field concerned. The heavy overapplication for funds available under these programs suggests that, for the present at least, Federal money will be most productive if it is used in this way. Obviously when the government has a particular interest in a particularly expensive installation of more than local importance, it must expect to meet all or nearly all the cost of the undertaking. There may also be other circumstances in which a particularly good opportunity for progress would be lost if "matching" were insisted on, and we believe that unmatched grants should be made in such cases.

VIII. New fields of research and education need particular encouragement

As we have already said, the national interest demands particularly rapid growth of research and training in a number of fields. The identification of these fields is a job for scientists, universities, and the government, all working together, but since the national interest *is* involved, particular responsibility for their support rests on the government. In such efforts the government must at times be willing to concentrate its support in relatively few places, and universities must avoid a log-rolling insistence on dispersion of efforts in many places at once. Moreover, in its support of these new subjects the government should place its bets where there is clear evidence that the institution concerned is prepared to establish and encourage programs of graduate education fully connected with new research.

IX. Separate research installations should be avoided whenever possible

The central proposition of this report is that science and the making of scientists go best together. This means that when it can be managed, basic research should be done in, or at least in association with, universities. Exceptions to this rule are numerous, of course. Some problems, by their nature, require attack in ways that are not suited to university life; and work of the Geological Survey, for example, can hardly be divided among the universities, yet it requires science of high quality, and basic research is essential to the whole undertaking; the same thing is true of many other enterprises of government and industry. Yet we hold to the view that in the absence of special considerations the university is the best place for basic research, and we note that the separate installations which do the best work are, as a rule, those which have a close and effective connection with academic centers; the Geological Survey, in its intimate relation to academic geology, is an excellent case in point.

X. New research laboratories for special fields should be attached to universities whenever it is practicable, and universities should make full educational use of such facilities

Since the beginning of World War II there have developed a number of major research installations which are supported by Federal money and operated by universities or groups of universities. At their best these installations have greatly contributed both to research and to education; we believe that this particular form of partnership between government and universities deserves encouragement and improvement.

In the best cases these laboratories have had the following advantages from their university connection: they have had the active participation of outstanding university scientists; their own ability to attract first-rate research men has been strengthened by the university's sponsorship; they have been stimulated to high standards of excellence by the standards of the university itself. At the same time the university has benefited from opportunities

for research and for the advanced training of graduate students, and its own ability to attract first-rate scientists has been strengthened.

XI. Scientists outside universities can be fruitfully connected to graduate education

In spite of the basic line of argument we have set forth in this report, American science is and will continue to be much more than the work of universities and directly affiliated laboratories. We believe that in this area there are indeed important opportunities that require exploration and exploitation by industry, by government, and by universities. Perhaps the simplest notion—and one of the best—is that it should be possible for research scientists in governmental or industrial laboratories to contribute to the graduate programs of nearby universities. This happens now, of course, but it should happen much more often; all parties should be eager to expand the practice. Government and business will serve their own interests by facilitating such teaching even to the extent of helping to pay for it, and universities for their part should be hospitable to qualified men even though they have chosen to pursue their research outside the academic fold.

XII. Postdoctoral studies should be encouraged and their legitimate costs recognized

One major element in strengthening both graduate education and basic research can be the postdoctoral fellow, who is ideally equipped to combine research with learning and both with a share of teaching. We believe that the nature of modern science makes it necessary that there should be many more members of this rapidly growing class; both universities and the government should recognize that such postdoctoral work is as necessary, and at least as expensive, as any other form of advanced training. Postdoctoral fellowships may have particular value in the development of new interdisciplinary fields; regular and rigorous exposure to a standard doctoral discipline is often an excellent preparation for entry into subjects which apply the tools of such a discipline to specific problems. The postdoctoral fellow is free to make this important and difficult transition.

XIII. University faculties must be strengthened

The growth of science depends on good facilities and good students—but most of all upon good scientific faculties. The professor is the heart of the enterprise. Without professors the universities quite simply cease to exist. They are, indeed, so essential that we often tend to take them for granted. In recent years, much good work has been done in calling attention to the shockingly low level of faculty salaries, and improvement is visible. But neither universities nor the Federal Government have yet recognized fully the absolutely focal role of the professor both in research and in graduate education. Both sides believe they understand the point, but both continue to tolerate policies that make it difficult for the country to have the services of an adequate number of adequately supported university scientists. That the United States today has a number of first-rate faculties is our greatest single scientific asset. To sustain them and to provide the conditions for the growth of more is the greatest single task of American university administrators.

In placing first and central responsibility upon the universities here, we do not mean to underestimate the importance of what government does or does not do—quite on the contrary. In our judgment the general pattern of Federal support for science has so far developed with very little regard for the problem of building strong faculties, and we think it urgent that careful thought be given to changes in policy that may help the universities discharge this great responsibility. The basic difficulty at present is that most Federal funds are tied to specific research projects in a way which makes it hard for universities, in making long-term appointments, to rely in any way on Federal funds. This difficulty is compounded in some agencies by policies which discourage the use of Federal money to pay the salaries of senior faculty people. We believe that these practices and policies need to be revised in the light of the proposition that nothing is more clearly in the general interest of the Federal Government than a rapid increase in the quality and quantity of the nation's teaching scientists.

There are many instruments that can be used here. At one extreme is the relatively simple practice of paying an appropriate share of the salaries of all faculty members engaged in a federally-supported project; we think that this policy should in general be adopted as an interim measure, even though it often has the disadvantage of perpetuating the misleading distinction between "teaching" and "research." At the other extreme is the method, now used in Great

Britain, of large general grants for all purposes to all universities; we doubt if any such pattern could or should be accepted here. In between are such devices as the training grant, which can often be used for professional salaries, and the so-called "institutional" grant, in which broadly inclusive support is offered for a relatively large sector—say "biological science"—over a relatively long period of time. We believe that the government and the universities should take energetic measures to put into effect programs in this middle ground, with the specific objective of making Federal money not simply a reinforcement of scientists already holding tenure, but a stimulus and a support in the appointment of more such men. We repeat that in the general interest a rapid increase in the number of such permanent professorial scientists is needed.

XIV. Universities must attend to these matters and especially to their relations with the Government

The nation's universities urgently need to improve their own ways of giving attention to the matters described in this report. In general, university administrators need to pay much more attention to the meaning and requirements of the age of science. In particular both administrators and faculty members need to improve their methods of dealing with the Federal Government. Many of the limitations and weaknesses we have found in government programs are the result of failures within the university. There is an urgent need for a stronger and clearer voice of higher education in Washington, and in particular there is need for more effective representation of those who are concerned with excellence in basic research and graduate education. Either existing agencies of representation should be greatly strengthened, or new patterns of action should be sought. The choice of means belongs to the universities themselves, but in any event we believe that the leading men in our university faculties and administrations should clearly recognize that a significant investment of their own time and effort will be continuously needed in this process.

XV. The Government must strengthen its ability to make policy in this area

Today when many separate agencies are deeply involved, when large national interests are at stake, and when programs not carefully coordinated can easily produce waste and even conflict, it is self-evident that the government should have the means for a well-coordinated and powerfully directed general policy. In our judgment, the final executive authority in this great field must necessarily lie in the office of the President where policy can be developed with the aid of the Special Assistant to the President for Science and Technology, the Federal Council for Science and Technology, and the President's Science Advisory Committee.

XVI. Increased Government activity is not a good ground for lessened efforts by others

We have urged in this report that the government should accept growing responsibility for effective support of graduate education and basic research. Our reasoning is pragmatic, not doctrinaire: government must do these things because by their size and nature no other agency can. But there is no reason to suppose that it will be good for the government to act alone, or for the rest of the forces in our plural society to stand aside. On the contrary, there is every reason for private and state funds to be sought, as eagerly and urgently as ever, and the very fact of increasing Federal support makes such other help an important safeguard against the possibility of undue government influence. In the same way, the government's own plurality of agencies is valuable, in spite of the occasional confusion and duplication it can cause. Even in the best of worlds there will be things which government money cannot or does not do, and private philanthropy will always be greatly needed in the whole field of scientific research and teaching.

PART THREE—RECOMMENDATIONS

The following recommendations grow out of the preceding parts of this report; they indicate the lines of development which we think urgent in the immediate future. But for the reader who may turn only to the recommendations, we wish to emphasize that the record of this country in basic research and graduate education is not one of failure. American science is second to none in the world, and the Federal Government, on balance, has played a highly constructive role in supporting it. Most of our specific recommendations are based on our respect for the best existing practices of particular agencies of government or particular universities.

These recommendations are not intended as criticisms of what has been accomplished, but as proposals for still greater accomplishment in the future.

General recommendations

1) In view of the growing importance of scientific research to national security and welfare, all parts of the national community should assume a greater responsibility for supporting, strengthening, and expanding basic research and graduate education.

2) In science the excellent is not just better than the ordinary; it is almost all that matters. It is therefore fundamental that this country should energetically sustain and strongly reinforce first-rate work where it now exists.

3) It is of equal importance to increase support for rising centers of science. Over the next fifteen years the United States should seek to double the number of universities doing generally excellent work in basic research and graduate education.

4) It should be a general basis of policy and action that basic research and the education of scientists go best together; that they are inseparable functions of universities; that in graduate education the training of scientists involves research; and that the strength of scientific research grows out of research training in institutions of higher education.

5) To attract more talented young people to science as a career, both undergraduate colleges and the Federal Government should give urgent attention to the quality of collegiate instruction in the sciences. Here again research and teaching need to be connected wherever possible, so that both teachers and students may have the opportunity for learning by scientific inquiry. Better salaries, increased time for research, rising support for facilities and equipment, and modernization of curriculum—all are needed in undergraduate colleges.

6) Both the universities and the Federal Government should be energetic and imaginative in seeking effective ways of identifying and supporting new fields of basic research and in supporting the training of scientists in such fields. Many research opportunities are emerging in new fields that are essentially interdisciplinary; these require special efforts by universities to encourage new programs. The Federal Government should stimulate and support such programs where there is clear evidence that the institutions are prepared to establish programs of graduate education fully connected with the new research.

7) State, local, and private resources are needed on a large and growing scale to meet the needs and opportunities in basic research and graduate education. While this report emphasizes the responsibilities of universities and the Federal Government, the very fact of growing Federal activity makes it urgent that state, local, and private efforts also be increased, for, especially as concerns private efforts, there will always be much that the government either does not or cannot do.

Recommendations for universities

1) Universities must continue and expand their efforts to pay proper salaries, provide adequate time and opportunity for research, and maintain an atmosphere of free learning and investigation.

2) Universities should recognize that graduate education in the sciences needs constant modernization.

3) University programs in graduate education should ordinarily include experience in both research and teaching, whether the student is headed for academic work or for industrial or governmental research. Such experience should be of a sort which advances the scientific effectiveness of the graduate student; it should not be limited to drudgery in support of the research or teaching of senior faculty.

4) Universities should give increased recognition to postdoctoral opportunities for promising students. Appropriate budgetary arrangements should be made for this form of education.

5) Universities should make full educational use of affiliated research installations. These installations should always be available to learning students, and members of research staffs should, wherever possible, be associated in the teaching processes of the university itself.

6) Universities should strengthen their faculties for both research and graduate teaching by accepting and using Federal as well as non-Federal support for faculty salaries.

7) The university community as a whole has a duty to inform the government clearly and in detail of the nature and needs of basic research and graduate education. There is urgent need for strengthening the quantity and quality of representation of universities before both the Congress and the Executive Branch.

8) Universities should accept primary responsibility for ensuring that their growing partnership with the government reinforces their freedom and excellence.

Recommendations for the Federal Government

1) Federal support for basic research and graduate education in the sciences should be continued and flexibly increased so as to support excellence where it already exists and to encourage new centers of outstanding work.

2) The Federal Government should continue and enlarge the practice, now followed with great success in a few agencies, of providing research support over long terms and for broad objectives.

3) Once support is granted, the Federal Government should not seek to supervise technical operations directly. Complete scientific responsibility for all phases of a research operation should remain with the universities. Here again the best practice of the most effective agencies is a good model for the government as a whole.

4) We repeat the recommendation of an earlier report that "Government departments and agencies concerned should uniformly modify the grant and contract provisions to permit universities and nonprofit research institutions to charge full cost of research performed for the government—including overhead—and to amortize capital expenditures as an allowable cost." [6]

This recommendation has been implemented to some extent, but still requires further attention if we are not to undermine the strength of the institutions which perform the needed research. Unless research is to be cut back, the recommendation does imply increased expense; as funds increase, the further implementation of this recommendation should have very high priority.

5) Since the Federal Government has a deep interest in a rapid increase in the quality and quantity of the nation's teaching scientists, its agencies should in general seek forms of support for basic research and graduate education which will permit universities to enlarge their permanent faculties. In particular, the government should allow charges against all Federal grants and contracts for time spent by faculty members on work so supported. (However, no such charges against grants and contracts should be permitted for extra compensation to individual faculty members during the regular academic year).

6) Federally-supported fellowship programs should be expanded when truly promising candidates can be found. Fellowships should be provided both directly to talented graduate and postdoctoral students, and also to selected universities for allocation to promising applicants. They should include a supplementary grant based on the full cost of such education. Such programs should not exclude the student from part-time assignments in research or teaching or from payment for such services when it is appropriate.

7) Federal support of facilities and equipment should be provided for both basic research and graduate education so as to increase the quality and quantity of research results and the number of trained scientists. Since the need for buildings and equipment is urgent, these should have high priority for the present. When the Federal Government has a particular interest in an installation of more than local importance, it should expect to meet all or nearly all the cost of the undertaking. In other cases, the practice of sharing the costs of facilities and equipment between the Federal Government and other sources should be encouraged, for the present at least, since it stimulates other sources of support and ensures that the receiving institutions have a serious commitment in the field concerned.

8) In the assignment of funds for basic research, the government should seek to promote the essential connection between the conduct of research and the training of scientists. Where it is feasible, new undertakings should be established in, or in close association with universities, and the great influence and effectiveness of basic research in existing government installations should be increased where possible by improving its connection to graduate education and to university scientists.

9) The government should strengthen its ability to establish general policies governing its support of basic research and graduate education at universities. These policies should be formulated under the leadership of the office of the President utilizing appropriate advisory machinery. The planning of Federal programs in these areas should allow for early and careful discussion with university leaders.

[6] *Strengthening American Science*, p. 34.

Staff: Panel on basic research and graduate education, the President's Science Advisory Committee

The panel

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Alvin M. Weinberg, director, Oak Ridge National Laboratory

John E. Willard, dean, Graduate School, University of Wisconsin

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Glenn T. Seaborg, chancellor, University of California, Berkeley (chairman)

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Office of Education Studies and Surveys

Academic Degrees

Academic Degrees: Earned and Honorary Degrees Conferred by Institutions of Higher Education in the United States, by Walter Crosby Eells and Harold A. Haswell (see New Publications Section) reports on the first comprehensive survey of American college degrees made in recent years. The study, undertaken to determine the extent of proliferation of degrees and their abbreviations, provides an authentic directory of American degrees, both earned and honorary.

The publication lists all degrees by official titles arranged by fields in which the degrees are conferred, alphabetically by title, and alphabetically by abbreviations. It indicates frequency of use for degrees that have more than one title or abbreviation.

The publication also supplies historical data about college degrees and makes suggestions which, if they are widely accepted, would tend to reduce the number of degrees offered and standardize their abbreviations. It reveals that more than 1,600 different academic degrees are currently conferred by colleges and universities in the United States, and that 800 other degrees have been offered or conferred but are not in current use. At least 235 different honorary degrees have been conferred by U.S. institutions of higher education, but only half of these are in current use.

Academic Degrees should be especially useful to registrars, deans, librarians, department chairmen, and other educational leaders responsible for determining degree plans. It should also serve as a ready reference on degrees for government employees, representatives of foreign governments, personnel officers, as well as the general public.

Study Abroad

OE's Clearinghouse of Studies on Higher Education announces the publication of *Study Abroad*, the sixth in the series *New Dimensions in Higher Education*. The new publications describes the status and trends of programs of group study abroad and practices at a number of institutions, illustrating patterns of the organized year abroad, the academic term, the summer session (abroad), and the study tour. It also discusses research efforts to determine the extent to which program objectives are being attained and the problems and potentials of group study abroad.

Under the editorship of Winslow R. Hatch of the Clearinghouse, the bulletin was prepared by Irwin Abrams, whose wide experience with programs abroad contributes substantially to the publication's usefulness, not only to institutions contemplating the expansion of existing programs or the establishment of new ones, but also to all those interested in finding ways to help prepare today's students to live in tomorrow's world (see New Publications Section).

Soviet Education Programs

Soviet Education Programs: Foundations, Curriculums, Teacher Preparation answers some of the many questions being asked in this country about Soviet education. The answers are based on firsthand information gathered by three Office of Education staff members: William K. Medlin, formerly specialist in comparative education for Eastern Europe and now associate professor of education at the University of Michigan; Clarence B. Lindquist, chief for natural sciences and mathematics; and Marshall L. Schmitt, specialist for industrial arts. The bulletin reports their month-long visit in May and June of 1959 to 15 general schools, 8 teacher-training institutions, and 6 pedagogical research institutes in Moscow, Kiev, Tbilisi, and Leningrad.

The bulletin covers not only the authors' observations of Soviet educational processes but also their conferences with Ministry of Education officials, directors of schools and pedagogical institutes, research workers, and classroom teachers. In addition, it reproduces a considerable amount of source material such as syllabuses and copies of examination questions that had been given to Soviet students. The examination questions give some idea of the level of knowledge expected of students in different grades.

The authors also discuss their visits to a number of experimental schools where new curriculums were being tried out in accordance with the recently de-

cared official policy that Soviet education must be more closely linked to everyday life. The major reforms in progress, they say, increasingly emphasize polytechnic education, extension of the general elementary and secondary education from 10 to 11 years, and reorganization and modernization of the curriculum in science and mathematics.

The chapter on teacher education describes the various types of institutions engaged in teacher preparation, organization and administration of teacher education programs, curriculums, professional training, methods of instruction, examination procedures, financial aid for students, faculty, correspondence and evening programs, and inservice institutes for teachers.

Soviet Education Programs: Foundation, Curriculums, Teacher Preparation, Bulletin 1960, No. 17 (OE–14037) is the third Office of Education bulletin on Soviet education published during the last 3 years. Copies may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., at $1.25 each.

1960 Fall Enrollment

FALL ENROLLMENT of full-time and part-time degree-credit students in the Nation's colleges and universities at the beginning of the 1960–61 scholastic year reached the all-time high of 3,610,000, according to summary data from the annual Opening (Fall) Enrollment Survey. The 1960 fall enrollment exceeds the 3,402,000 enrollment of 1959 by 6.1 percent. This was the ninth consecutive year that a rise was reported in fall enrollments. The 1960 figure was 34.8 percent above the 1955 figure.

The number of students enrolled in college for the first time rose to 930,000, a jump of 12.4 percent over the fall of 1959. This sharp increase is expected to be reflected in total enrollment and number of graduates in future years. The enrollment of "continuing" (all except first time) students rose to 2,680,000, a 4.1 percent increase over 1959.

The 1960 fall enrollees included 2,271,000 men and 1,339,000 women, compared with 2,174,000 men and 1,229,000 women in the fall of 1959. The percentage increase for men was 4.5; for women it was 9.0. Of the first-time enrollees this fall, 543,000 were men and 387,000, or 41.6 percent, were women. In the fall of 1959, 491,000 of the new enrollees were men and 336,000, or 40.7 percent, were women.

The survey includes only degree-credit students. These are students whose current program consists principally or wholly of work leading toward a bachelor's degree or higher. Reported enrollments include both resident and extension degree-credit students, full time and part time, studying either in the day or in the evening.

Of the approximately 2,000 institutions listed in the Higher Education section of the U.S. Office of Education *Education Directory*, all of those which give degree-credit programs were included in the

Total and first-time opening (fall) degree-credit enrollment,[1] by sex: aggregate United States, 1955–60

Year	Total degree-credit enrollment			First-time degree-credit enrollment[2]		
	Both sexes	Men	Women	Both sexes	Men	Women
Enrollments:						
Fall 1960	3,610,007	2,270,640	1,339,367	929,823	542,774	387,049
Fall 1959	3,402,297	2,173,797	1,228,500	826,969	490,622	336,347
Fall 1958	3,258,556	2,110,426	1,148,130	781,075	468,625	312,450
Fall 1955	2,678,623	1,747,429	931,194	675,060	418,363	256,697
Percent changes:						
1959 to 1960 (1 year)	+6.1	+4.5	+9.0	+12.4	+10.6	+15.1
1958 to 1960 (2 years)	+10.8	+7.6	+16.7	+19.0	+15.8	+23.9
1955 to 1960 (5 years)	+34.8	+29.9	+43.8	+37.7	+29.7	+50.8

[1] Degree-credit students are those whose programs consist wholly or principally of work normally creditable toward a bachelor's or a higher degree. Resident and extension degree-credit students, full-time and part-time, are included. However, the survey does *not* include students taking degree-credit work at home by mail, radio, or TV. *Also excluded* are all students in those branches of U.S. institutions operated in foreign countries.

[2] A first-time degree-credit student is one who is reported as a degree-credit student but who has not previously been a degree-credit student in *any* institution of higher education. Students were reported as "first-time" in this survey if the fall of 1960 marked their first enrollment in any institution for programs of the degree-credit type.

opening fall enrollment survey. Included are universities, liberal arts colleges, teachers' colleges, theological and religious institutions, other types of independently organized professional schools, and junior colleges.

Data on individual institutions from the survey are covered in a circular issued in the fall. Data by type of institution and study of trends will be covered in an article in a later issue of *Higher Education* and in an analytic report on college enrollments to be separately published.

E. M. Huddleston
J. Lewis
Division of Statistics and Research Services

National Defense Education Act Notes

Institute Advisory Committee Named

At Commissioner Derthick's request, 12 well-known educators will serve as an advisory committee to the Office of Education in developing its program of counseling and guidance institutes. The program is financed under the National Defense Education Act. The committee members are:

Irby B. Carruth, superintendent of schools, Austin, Tex.; Clifford E. Erickson, dean, College of Education, Michigan State University; Herold C. Hunt, professor of education, Graduate School of Education, Harvard University; James D. Logsdon, superintendent, Thornton Township High School and Junior College, Harvey, Ill.; James Madison Nabrit, Jr., president, Howard University; Carroll V. Newsom, president, New York University; Edward S. Noyes, acting president-elect of the College Entrance Examination Board, New York, N.Y.; Edward J. O'Donnell, president, Marquette University; Dael Wolfle, administrative secretary, American Association for the Advancement of Science; B. Alden Thresher, director of admissions, Massachusetts Institute of Technology; E. G. Williamson, dean of students, University of Minnesota; and Anna L. Rose Hawkes, president, American Association of University Women.

The program is designed to improve the professional qualifications of secondary school counselors and teachers who are training to be counselors. The institutes are conducted at colleges and universities and stress the importance of early identification of able boys and girls.

Since the passage of NDEA 2 years ago, 133 summer institutes and 28 regular-session institutes have provided training to more than 6,200 secondary school counselors and teachers. About 3,400 counselors and teachers will attend the 82 institutes that have been tentatively scheduled for next summer and the 22 institutes during the 1961–62 academic year.

Advisory Committee Chairman Appointed

John E. Ivey, consultant to the president of Michigan State University, will head a special advisory committee of educators to evaluate the effect of federally sponsored programs in higher education. The committee will work directly with J. Kenneth Little, Director, Survey of Federal Programs in Higher Education, for the U.S. Office of Education.

"We are acting under provisions of title X of the National Defense Education Act which requires the Secretary of Health, Education, and Welfare to obtain full information about all scholarship, fellowship, or other educational programs administered by any Federal department or agency," Commissioner Derthick said in announcing the appointment.

The number of Office of Education programs in higher education was greatly increased by the passage of the National Defense Education Act in 1958. The committee is now studying preliminary material Dr. Little has submitted on these and other Federal programs.

Other members of the committee are:

McGeorge Bundy, dean, Faculty of Arts and Sciences, Harvard University; Felton G. Clark, president, Southern University (Louisiana); Douglas Knight, president, Lawrence College (Wisconsin); Herbert E. Longenecker, president, Tulane University; Lee A. DuBridge, president, California Institute of Technology; John A. Perkins, president,

University of Delaware; Paul C. Reinert, S.J., president, St. Louis University; M. H. Trytten, director, Office of Scientific Personnel, National Academy of Sciences; John C. Weaver, dean, Graduate School, University of Nebraska; Helen C. White, professor, Department of English, University of Wisconsin; and Charles E. Odegaard, president, University of Washington.

Other Program Notes

AEC Awards Grants Totaling $1,547,538

THE Atomic Energy Commission approved, during November 1960, grants totaling $1,547,538 to 113 educational institutions for purchasing laboratory equipment for nuclear education programs in the life and physical sciences and engineering. In the 4 years since the Commission initiated programs to assist in providing trained manpower for the atomic energy field and in orienting students in science and engineering in nuclear phenomena, it has provided $18,407,892 to 330 educational institutions for instructional equipment. It has also loaned about $10 million worth of nuclear materials to many of these institutions.

The new equipment grants are within three general categories: (1) Physical sciences and engineering awards to 59 institutions, $1,040,174; (2) life sciences awards to 50 institutions, $423,255; and (3) isotope technology awards to 10 institutions, $84,109.

The AEC is tentatively planning another series of grants to educational institutions in April 1961 for purchase of nuclear laboratory equipment.

Research Center Funds Increase

FEDERAL contract research centers administered by educational institutions are receiving an increasing share of the college and university research and development dollar, the National Science Foundation has reported.

In fiscal year 1958 the 28 Federal contract research centers administered by educational institutions spent $289.1 million for research and development—$285.3 million of it from Federal sources and $3.8 million from non-Federal. The 1958 total was twice the amount spent in fiscal year 1954, when the last study was made. It represents 39 percent of R&D expenditures of colleges and universities during the 1957–58 academic year as compared to 32 percent in 1953–54.

The bulk of the R&D expenditures in 1958 went into engineering ($117.1 million) and the physical sciences ($157.7 million). Approximately $70 million, or 25 percent of the total, was reported as having been spent on basic research.

The study of Federal contract research centers was part of a comprehensive survey of expenditures and manpower for research and development in colleges and universities. The preliminary data from the Foundation survey are reported in *Review of Data on Research & Development*, No. 23, "Federal Contract Research Centers in Colleges and Universities, Fiscal Year 1958" (see New Publications Section).

Scientific and Engineering Employment Grows

MORE than 800,000 scientists and engineers were employed by U.S. business firms in January 1960, a rise of nearly 7 percent over the 764,000 employed in January 1959, which in turn was slightly higher than the 5 percent rise between 1958 and 1959. The greatest percentage increase was in the employment of physical scientists, but the greatest numerical increase was in engineers—industry employed 40,000 more engineers and 10,000 more physical scientists in January 1960 than in January 1959.

These figures are based on preliminary estimates of a survey of 10,000 business firms the Bureau of Labor Statistics conducted for the National Science Foundation. They do not include scientists and engineers employed in small firms or self-employed. The National Science Foundation will publish a final report on the survey early in 1961, presenting detailed employment statistics. Preliminary figures in this release may be revised after detailed analysis.

Nearly 40 percent of the engineers and scientists were engaged in research and development activities (including administration of R&D programs), according to preliminary estimates. This represents a

significant increase over R&D employment in 1959 and is undoubtedly related to the greater-than-average increase in scientific employment during the 1959–60 period.

Two industries—electrical equipment and aircraft and parts—each employed approximately 100,000 scientists and engineers in January 1960. Other manufacturing industries employing more than 50,000 scientists and engineers included chemicals and allied products, machinery, and petroleum products (including extraction).

Employment of scientists and engineers, by occupational group

[Preliminary data]

Occupational group	January 1960		Percent change 1959–60
	Number	Percent	
Total scientists and engineers	815,500	100.0	6.7
Engineers	656,300	80.5	6.6
Scientists	159,200	19.5	7.1
Chemists	76,900	9.4	7.6
Other physical scientists	57,100	7.0	9.0
Life scientists	18,800	2.3	3.9
Unclassified scientists	6,400	.8	−3.0

NSF Announces Institute Program

THE National Science Foundation has awarded about $9,800,000 in grants to 43 colleges and universities to support Academic Year Institutes for science and mathematics teachers. This program, now in its sixth year, is designed to help teachers improve their subject-matter knowledge, especially in the newer developments in science and mathematics, through a year's advanced study on a full-time basis.

Approximately 1,500 experienced junior and senior high school teachers will attend the institutes during the 1961–62 academic year. Each teacher will pursue a course of study in science or mathematics planned especially for him and conducted by scientists noted both for competence in their fields and for skill in presentation.

About 75 teachers from liberal arts colleges, teachers colleges, and junior colleges will also be included in the program. They will be chosen from those who have primary responsibilities for the training of prospective science and mathematics teachers.

The Academic Year Institutes program has in its 5 preceding years enabled about 4,800 science and mathematics teachers to keep abreast of the latest scientific developments. Reports from participants in the program, from their supervisors, and from observers strongly indicate that the influence of these trained teachers raises the general level of science instruction in secondary schools and tends to motivate students to undertake science careers.

The Foundation grants will provide stipends of $3,000 for each participant, with additional allowances for dependents, books, and travel. Some institutes will provide an additional summer training program to enable teachers more easily to fulfill graduate degree requirements. Supplementary allowances will be provided for teachers participating in this extended program.

PHS Grant to Cornell

UNDER a U.S. Public Health Service 5-year grant of $172,000, beginning July 1, 1961, the School of Engineering, Cornell University, will set up the first comprehensive program to make full use of systems-engineering methods and computer technology in sanitary engineering. Charles D. Gates, head of the Sanitary Engineering Department, will be in charge of the project, which will be carried out on the Cornell campus.

Experts believe that the use of systems engineering—a method of analyzing and finding the most effective design and operation for a complex system as a whole—can help solve many problems facing sanitary engineers. Some problems are of national concern, for example, adequate water supply and waste disposal systems for a rapidly increasing population, treatment of industrial and nuclear wastes and air sanitation, and radiological health problems.

The method is already being used in solving industrial and military problems containing many interrelated components. The use of computers in solving such problems depends on simulation techniques similar to those used by industrial engineering experts in computer programing. Once the various physical, chemical, and biological factors with which sanitary engineers must deal have been simulated, research and design problems that require vast amounts of time and money can be solved quickly at relatively low cost.

Data taped or printed on cards are stored in the computer's "memory." Entire water supply and waste disposal systems will be represented in the data by symbols and numbers. Problems, also represented by symbols and numbers, can be fed to such paper plants and facilities.

But before simulation techniques can be refined enough to be useful to sanitary engineers, the teaching of sanitary engineering must take advantage of computer programed systems analysis. Cornell's project is expected to produce sweeping changes in teaching and research in sanitary engineering.

NEW PUBLICATIONS

Government Publications

How To Obtain

(*1*) *Cost Publications: Send request, enclosing remittance (check or money order), to the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.*

(*2*) *Free Publications: Request direct from the agency issuing them.*

From the Office of Education

Criteria for the Establishment of 2-Year Colleges, by D. G. Morrison and S. V. Martorana. Washington, U.S. Government Printing Office, 1960. Paper, 101 p. (OE–57000.) 45 cents.

Surveys the criteria for establishing 2-year colleges as found in State laws and regulations, in statewide studies, and in the literature on junior colleges, and in the opinions of leaders in the 2-year college field. The study examines the criteria for both public and private 2-year colleges and includes guidelines for State legislation relating to public 2-year colleges.

Research Problems in Mathematics Education: Reports from a Conference on Psychological Problems and Research Methods. (Cooperative Research Monograph No. 3.) Washington, U.S. Government Printing Office, 1960. Paper, 130 p. 55 cents. (OE–12008.)

Presents the findings of a 3-month Cooperative Research Project sponsored by Washington University in cooperation with the U.S. Office of Education. Includes: *Review of Completed Research*, a survey of psychological and educational literature 1948–58, with special reference to research applicability in the field of mathematics training (accompanied by a list of selected references); *Problem Areas*, discussions of problems in the field of human learning, with special reference to the learning of mathematics; and *Proposals for Further Research*, a collection of research designs in the field of mathematics training.

A Statistical Comparison of Graduate Degrees Awarded by Members of the Association of Graduate Schools and by All U.S. Universities, 1957–58, by John L. Chase, James H. Blessing, and Grandis L. King. U.S. Department of Health, Education, and Welfare, September 1960. 27 p. (OE–54011.)

Study Abroad, New Dimensions in Higher Education, Number 6, by Irwin Abrams *and* W. R. Hatch. Washington, U.S. Government Printing Office, 1960. Paper, 21 p. 15 cents. (OE–50014.)

Academic Degrees: Earned and Honorary Degrees Conferred by Institutions of Higher Education in the United States, by Walter Crosby Eells *and* Harold A. Haswell. Washington, U.S. Government Printing Office, 1960. Paper 324. Price $1.

Soviet Education Programs: Foundations, Curriculums, Teacher Preparation, by William K. Medlin, Clarence B. Lindquist, *and* Marshall L. Schmitt. (Bulletin 1960 No. 17.) Washington, U.S. Government Printing Office, 1960. Paper, 281 p. $1.25. (OE–14037.)

Studies in Comparative Education—Bibliography: 1959 Publications in Comparative and International Education. Washington, U.S. Government Printing Office, 1960. Paper, 118 p. 75 cents. (OE–14004–59.)

Statistical Summary of State School Systems 1957–58, by Samuel Schloss *and* Carol Joy Hobson. Washington, U.S. Government Printing Office, 1960. Paper, 14 p. 15 cents. (OE–20016.)

Other Government Agencies

Funds for Research and Development in Industry, 1957: Performance and Financing. Washington, U.S. Government Printing Office, 1960. (National Science Foundation, Surveys of Science Resources Series, NSF 60–49.) Paper, 119 p. 65 cents.

This report, prepared by NSF on the basis of summary data provided by the Bureau of the Census, presents the results of a 1957 survey on the magnitude, types, and economic characteristics of research and development in the private industry sector of the economy.

Part I summarizes the characteristics of industrial research and development and compares data on

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R&D performance and financing and on company size-groups; part II summarizes 1957 data on the R&D activities of ten selected industries.

Federal Contract Research Centers in Colleges and Universities, Fiscal Year 1958. (National Science Foundation, Reviews of Data on Research & Development series, NSF60-61, Number 23, October 1960.) Washington, U.S. Government Printing Office, Washington 25, D.C. Paper, 4 p. 5 cents.

Monthly Catalog of United States Government Publications, September 1960, No. 788. Issued by Superintendent of Documents, U.S. Government Printing Office, 1960. Paper, 207 p. 25 cents.

Nongovernment Publications

The Evolving Liberal Arts Curriculum, A Historical Review of Basic Themes, by Willis Rudy. Monograph, Bureau of Publications, Teachers College, Columbia University, New York, N.Y. 135 p. $3.

More Resources for Education, by Seymour E. Harris, 49 East 33d Street, New York 16, N.Y. Harper & Bros., 1960. 86 p. $2.95.

Explores the educational needs of the United States for the next 10 years and the availability of resources to meet those needs. Factors discussed in detail include the rising costs of education, productivity of the educational system, size and growth of our national economy, trends in spending for consumer goods, changes in disposable income (personal income after direct taxes), and competition for the tax dollar (Federal, State, and local).

The Overseas Americans, by Harlan Cleveland, Gerard J. Mangone and John Clarke Adams. McGraw-Hill Book Company, Inc. 316 p. $5.95.

This publication is the result of a study, sponsored by the Carnegie Corporation, by three members of the faculty of the Maxwell Graduate School of Citizenship and Public Affairs, of Syracuse University. Presents a detailed analysis of the characteristics of American citizens who live abroad, the factors which have resulted in their going abroad, the problems they encounter, the activities in which they engage, and the contribution they make to the American image abroad. Considers also the elements of effective performance by overseas Americans, the needed skills, background and attitudes, and the opportunities and responsibilities of colleges and universities for preparing Americans for effective overseas service.

Representative American Speeches: 1959–1960, by Lester Thonssen. H. W. Wilson Co., Publishers, 950 University Avenue, New York 52, N.Y. 1960. 203 p. Clothbound. $2.50. (The Reference Shelf: Volume 32, Number 4.)

Presents 17 notable addresses made during the past year, including such prominent speakers as President Eisenhower, Vice President Nixon, Senator Kennedy, Congressman Chester Bowles, and Secretary of State Christian Herter. This selection of speeches expresses, with rhetorical distinction, vital ideas of our times. It covers such subjects as foreign aid, disarmament, national prestige, education, civil rights, labor-management relations, and other controversial issues.

Selected Bibliographies for Administrators in Higher Education, by F. Robert Paulsen. Processed, 31 p. Single copies free on request from Director, Center for the Study of Higher Education, University of Michigan, Ann Arbor, Mich.

The Southern Regional Education Board: Ten Years of Regional Cooperation in Higher Education, by Redding S. Sugg, Jr., *and* George Hilton Jones. Louisiana State University Press, Baton Rouge 3, La. 158 p. $4.

University Adult Education: A Guide to Policy, by Renee and William Petersen and Warren Rovetch. 49 E. 33d Street, New York 16, N.Y., Harper & Bros., 1960. 288 p. $5.50.

Presents a factual survey and critical analysis of university adult education with the central theme that much of what passes for adult education in many universities is substandard, commercialized, or not education at all. Deals primarily with the broad questions of institutional responsibility and policy in university adult education, but also examines the implications of this approach in the subject-matter field of foreign affairs and the important organizational question of whether general extension and cooperative extension may be brought together within a single administrative framework. A bibliography consisting of 478 items is included.

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